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ELECTRIC POWER RATES AND METHOD OF COMPUTING COST OF ELECTRIC POWER CONSUMED IN USSR MINES

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At present, mines in the USSR pay for electric power in accordance with a double-rate tariff. Under this system, enterprises pay monthly for the installed capacity (in kilovolt-amperes) of their transformers and high-voltage motors and for each metered kilowatt-hour of active power.

The first tariff is considered a base payment and the second one, a supplementary payment.

Table 1 [appended] contains tariffs for electric power generated by regional power administrations, power combines, and power stations of principal power systems.

The base payment is a means of enforcing rational utilization of the capacities of transformers and high-voltage motors, of ensuring a uniform load, and of obtaining a high power factor.

The base payment depends on the rated capacity of high-voltage transformers (50 kilovolt-amperes and above), regardless of where they are installed.

The capacity (in kilowatts) of high-voltage motors is taken from the name plate and then, on computing the tariff base payment, is converted by dividing the capacity of the motor by the power factor.

The capacity of reserve (sealed) transformers and high-voltage motors which have been installed to meet requirements of the mine-engineering inspectorate is not subject to base payment.

When the power factor at the customer varies from 0.85, the organization which supplies power either gives the customer a reduction or requires him to pay an extra amount over the base and supplementary payments as indicated in a scale [established by the Ministry of Electric Power Stations USSR], as shown in Table 2.

If, with consent of the power system, an enterprise achieves a power factor of better than 0.85 for its electrical installations by using synchronous compensators and by synchronization of asynchronous motors [conversion of wound-rotor induction motors into synchronous motors], then the reduction in payment is made not according to the scale, but in an amount of 0.5 percent for each 0.01 increase in the power factor up to the maximum established by the power system.

Actual payment for electric power is computed as follows.

1. Payment for Connected High-Voltage Capacity

$$A = (R_{dv} + R_{tr})k_1,$$

where R_{dv} is the capacity of connected high-voltage motors (dvigatel') expressed in kilovolt-amperes; R_{tr} is the capacity of connected transformers (transformator) expressed in kilovolt-amperes; k_1 is the cost of one kilovolt-ampere of connected high-voltage capacity as shown in the tariff (Table 1);

2. Payment for Electric Power Consumed per Month (as shown on meter)

$$B = Wk_2,$$

where W is the amount of power recorded by the meter in a month expressed in kilowatt-hours; k_2 is the cost of one kilowatt-hour, as shown in the tariff (Table 1);

3. Reduction or Increase in Payment for Power Factor

$$C = \frac{(A+B)k_3\%}{100}$$

where $k_3\%$ is the factor which determines the reduction or increase in the payment for electric power, expressed in percent; it is derived from the power factor scale (Table 2) on the basis of the average mean power factor. The average mean power factor is determined by the amount of active and reactive power consumed (as shown by meters) and is based on the formula

$$t_{g\varphi 1} = \frac{W(\text{kvar-h});}{W(\text{kw-h})}$$

4. Total Cost of Electric Power per Month

$$D = A + B \pm C$$

For example, the following problem, to determine the cost of electric power consumed in one month by a mine which receives its power from the "Donbassenergo" System, illustrates this formula. The installed capacity of high-voltage motors in the mine is $R_{dv} = 850$ kilovolt-amperes and of transformers $R_{tr} = 1{,}250$ kilovolt-amperes. The meter shows the amount of active power consumed in one month W(kw-h) = 726,000 and the amount of reactive power W(kvar-h) = 780,000 kvar-h.

1 Payment for Installed High-Voltage Capacity

$$A = (R_{dv} + R_{tr})k_1 = (850 + 1{,}250)10.2 = 21{,}420 \text{ rubles}$$

(k_1 is the monthly cost of one kilovolt-ampere of connected high-voltage capacity, as shown in Table 1: $k_1 = \frac{122}{12} = 10$ rubles, 20 kopecks.)

2. Payment for Active Power According to the Meter

$$B = W(\text{kw-h})k_2 = 726{,}000 \times 0.05 = 36{,}300 \text{ rubles}$$

3. Average Mean Power Factor

$$t_{g\varphi} = \frac{W(\text{kvar-h})}{W(\text{kw-h})} = \frac{780{,}000}{726{,}000} = 1{,}078$$

(According to the trigonometric tables $\cos\varphi_1 = 0.68$.)

4. The Extra Payment for Low Power Factor k_3 (Table 2) = 31%

$$C = \frac{(A+B)k_3}{100} = \frac{(21{,}420 + 36{,}300)31}{100} = 17{,}893 \text{ rubles, 20 kopecks}$$

5. Total Cost of Electric Power for one Month

$$D = A + B + C = 21{,}420 + 36{,}300 + 17{,}893.20 = 75{,}613 \text{ rubles, 20 kopeck}$$

[Note: Appended tables follow.]

Table 1. Tariff of Double Rates for Determining Cost of Electric Power Consumption in Mines of the USSR

Name of Power System	Annual Base Payment (in rubles)		Supplementary Payment for Each Metered kw-h (in kopecks)	
	Per one kva of [installed] Capacity	Per one kw of Max Load	On Primary [high] Voltage Side	On Secondary [low] Voltage Side
Mosenergo	128	--	11.2	11.6
Donbassenergo	122	301	4.7	5.0
Dneproenergo	112	162	3.6	3.9
Rostovenergo	108	216	5.9	6.1
Azcherenergo	99	158	11.1	12.1
Sevkazenergo	204	333	8.9	9.4
Kievenergo	140	270	9.5	10.0
L'vovenergo	87	180	11.9	12.3
Khar'kovenergo	174	374	6.9	7.3
Krymenergo	227	454	11.7	12.4
Lenenergo	184	360	13.5	14.1
Estonenergo	480	639	22.1	23.3
Uralenergo	171	405	7.7	8.0
Kirovenergo	414	--	22.5	23.7
Kemerovenergo	199	360	3.8	4.1
Krasnoyaskenergo	331	450	11.2	11.7
Novosibirskenergo	143	252	5.9	6.2
Omskenergo	217	360	10.4	11.0
Tomskenergo	338	450	6.3	6.8
Dal'energo	324	495	21.6	22.5
Kazakhenergo	324	450	22.5	23.4
Karagandaenergo	232	338	8.6	9.2
Uzbekenergo (Tashkentskiy Rayon)	145	198	5.4	5.8
Uzbekenergo (Ferganskiy Rayon)	297	450	6.3	6.8
Gruzenergo	79	158	5.0	5.3

Table 2. Scale of Allowances and Penalties in Computing Power Factor in Cost of Electric Power Consumption

Power Factor	Reduction in Electric Power Cost (in %)	Increase in Electric Power Cost (in %)	Power Factor	Reduction in Electric Power Cost (in %)	Increase in Electric Power Cost (in %)
1	20	--	0.74	--	16.0
0.99	20	--	0.73	--	17.5
0.98	20	--	0.72	--	19.0
0.97	20	--	0.71	--	22
0.96	18	--	0.70	--	25
0.95	16	--	0.69	--	28
0.94	14	--	0.68	--	31
0.93	12	--	0.67	--	34
0.92	10	--	0.66	--	37
0.91	8.5	--	0.65	--	40
0.90	7.0	--	0.64	--	43
0.89	5.5	--	0.63	--	46
0.88	4.0	--	0.62	--	49
0.87	2.5	--	0.61	--	52
0.86	1.0	--	0.60	--	55
0.85	--	--	0.59	--	58
0.84	--	1.0	0.58	--	61
0.83	--	2.5	0.57	--	64
0.82	--	4.0	0.56	--	67
0.81	--	5.5	0.55	--	70
0.80	--	7.0	0.54	--	73
0.79	--	8.5	0.53	--	76
0.78	--	10.0	0.52	--	79
0.77	--	11.5	0.51	--	82
0.76	--	13.0	0.50	--	85
0.75	--	14.5	--	--	--

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